CONTINUOUS PAPER FEEDING DEVICE AND PRINTER INCORPORATING THE SAME

RELATED APPLICATIONS

The present application claims priority to Japanese Patent Application No. 2000-259553 filed August 29, 2000, the entire content of which is hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

This invention relates to continuous paper feeding devices for feeding continuous paper sheets, and in particular, to printers for printing images on perforated printing paper sheets.

BACKGROUND OF THE INVENTION

Conventional printers adapted for printing on continuous paper sheets employ a tractor feeder which is capable of horizontally feeding printing paper sheets as a feeding device for feeding continuous paper sheets in order to realize their downsizing. The tractor feeder is configured to feed a printing paper sheet by causing feed pins of a rotary-driven endless tractor to sequentially engage perforations arranged with a predetermined pitch

longitudinally of the printing paper sheet.

As is often the case with such continuous paper printers, the feeding device is located upstream of the printing device (the printing device including, for example, a photosensitive drum and the like), while another feeding device (such as fusing rollers) is located downstream of the printing device. In this case, it is common practice to set the feeding speed of the downstream feeding device to be slightly higher than that of the tractor. This allows a printing paper sheet under feeding to be brought into close contact with the printing device. For this reason, the tension on the peripheral edge of each perforation is excessive when compared to the rest of the printing paper sheet under feeding. Hence, "hole breakage", which is a perforation enlarging phenomenon, is likely to occur. The occurrence of heavy hole breakage results in feeding the printing paper sheet, thereby causing a deviation from the predetermined printing position.

Japanese Patent Laid-Open Gazette No. HEI 7-215551 discloses a continuous paper feeding device incorporating a load imposing mechanism located upstream of the tractor for exerting a constant braking force on the printing paper

sheet to prevent an excessive tensile stress from working on the peripheral edge of each perforation.

The continuous paper feeding device disclosed in this Gazette applies a constant braking force to the printing paper sheet, as described above. For this reason, if the balance between the feeding forces respectively working on the upstream and downstream sides of the feeding device, such as the tractor, is lost even slightly, a deviation in the positioning of the paper sheet relative to the photosensitive drum occurs due to such an imbalance, thus resulting in a lowered precision in positioning for printing.

SUMMARY OF THE INVENTION

The present invention provides a continuous paper feeding device having a higher feeding precision.

The present invention also provides a continuous paper feeding device which is free from the hole breakage problem.

The present invention also provides a printer which is capable of printing on a continuous paper sheet with a higher positioning precision.

In one embodiment of the invention, there is a

continuous paper feeding device for feeding a perforated continuous paper sheet. The device includes, for example, a paper supply device configured to supply the continuous paper sheet; a tractor configured to feed the continuous paper sheet supplied from the paper supply device while engaging perforations of the continuous paper sheet; a braking device located between the paper supply device and the tractor and configured to apply a braking force to the continuous paper sheet; a braking force setting device for setting the braking force; and a controller for controlling the braking force applied by the braking device according to the setting made by the braking force setting device.

With this continuous paper feeding device, when a continuous printing paper sheet supplied from the paper supply device is fed by the tractor, the controller controls the braking force applied by the braking device according to the braking force set by the braking force setting device. Accordingly, a high feeding precision can be ensured because the continuous paper sheet is applied with an optimized braking force, even under such situations as to cause the paper feeding force to become unstable. Further, it is possible to inhibit the occurrence of hole breakage.

In another embodiment of the invention, there is a printer for printing an image onto a perforated continuous paper sheet. The printer includes, for example, a paper supply device configured to supply the continuous paper sheet; a tractor configured to feed the continuous paper sheet supplied from the paper supply device while engaging perforations of the continuous paper sheet; a printing device configured to print the image onto the continuous paper sheet at a location downstream of the tractor; a braking device located between the paper supply device and the tractor and configured to apply a braking force to the continuous paper sheet; a braking force setting device for setting the braking force; and a controller for controlling the braking force applied by the braking device according to the setting made by the braking force setting device.

The printer of the above construction is capable of printing images onto a continuous paper sheet with a high positioning precision. The feeding speed on the downstream side of the printing device is desirably made higher than that of the tractor to prevent the continuous paper sheet from slackening at a location adjacent the printing device. Even in this case, the balance between the feeding forces respectively working on the upstream and downstream sides

of the tractor can be maintained by the braking force applied by the braking device, thereby ensuring a high print position precision.

The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a principal portion of a continuous paper feeding device as a first embodiment of the present invention.

Fig. 2 is a perspective view showing a tractor of the continuous paper feeding device.

Fig. 3 is a partially cutaway perspective view showing a braking device of the continuous paper feeding device.

Fig. 4 is a sectional view taken along line IV-IV in Fig. 3.

Fig. 5 is a front elevational view showing a brake value setting picture presented by a setting panel.

Fig. 6 is a diagram showing the relationship between a braking force and a set brake value.

Fig. 7 is a flowchart of an operational sequence of the continuous paper feeding device.

Fig. 8a is a table showing a set brake value corresponding to a braking force for each paper sheet thickness.

Fig. 8b is a table showing a set brake value corresponding to a braking force for each paper sheet width.

Fig. 8c is a table showing a set brake value corresponding to a braking force for each humidity degree of a printer-installed environment.

Fig. 9 is a perspective view showing a principal portion of a continuous paper feeding device as a second embodiment of the present invention.

Fig. 10 is a perspective view showing a principal portion of a continuous paper feeding device as a third embodiment of the present invention.

Fig. 11 is a perspective view showing a principal portion of a continuous paper feeding device as a fourth embodiment of the present invention.

Fig. 12a illustrates a perforation free of hole breakage.

Fig. 12b illustrates a perforation with hole breakage

at its peripheral edge on the upstream side.

Fig. 12c illustrates a perforation with hole breakage at its peripheral edge on the downstream side.

Fig. 13a illustrates a perforation free of hole breakage.

Fig. 13b illustrates a perforation with hole breakage at its peripheral edge on the upstream side.

Fig. 13c illustrates a perforation with hole breakage at its peripheral edge on the downstream side.

In the following description, like parts are designated by like reference numbers throughout the several drawing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described in detail by way of embodiments thereof with reference to the drawings.

Fig. 1 is a perspective view showing a continuous paper feeding device as a first embodiment of the present invention. In Fig. 1, continuous paper feeding device A is incorporated in a laser printer. The continuous paper feeding device A comprises a paper supply section 20 as a paper supply device, a feeding section 2 adapted to feed a

continuous printing paper sheet 1 supplied from the paper supply section 20, a printing device 3 disposed downstream of the feeding section 2, a fusing section 4 located downstream of the printing device 3, a braking device 19 disposed upstream of the feeding section 2, a motor control section 7 for controlling a fan motor of the braking device 19, and a CPU 10 for controlling each section.

The paper supply section 20 accommodates the printing paper sheet 1 in a folded state, the paper sheet 1 having perforated lines P along which the paper sheet 1 can be cut at predetermined longitudinal intervals.

When the printing paper sheet 1 (set on the feeding section 2) receives a feeding force, the printing paper sheet 1 is delivered our of the paper supply section 20 in a direction indicated by arrow a. As better shown in Fig. 2, the printing paper sheet 1 has one widthwise side portion defining multiple perforations 11 arranged in a row, with a predetermined pitch longitudinally of the paper sheet 1. These perforations 11 are sequentially engageable and disengageable with feed pins (described below).

The printing device 3 has a photosensitive drum 22, a transfer roller 13 in rotary contact with the photosensitive drum 22, and the like. A toner image is

formed on the photosensitive drum 22 according to image data by an exposure system (not shown) and a developing device 22a and then transferred to a surface of the printing paper sheet 1.

The fusing section 4 has a pair of fusing rollers 4a and 4b pinching and rotary-contacting the printing paper sheet 1 thicknesswise thereof, and functions to fuse the toner image onto the printing paper sheet 1 by heating and pressurizing the printing paper sheet 1. The fusing rollers 4a and 4b apply a feeding force to the printing paper sheet 1 because of their rotary contact with the printing paper sheet 1. The feeding speed at this point is therefore slightly higher than that at the feeding section 2. The printing paper sheet 1 is thus prevented from slackening at a location adjacent to the printing position of the printing device 3, thus ensuring favorable transfer of the toner image from the photosensitive drum 3 to the printing paper sheet 1.

As shown in Fig. 2, the feeding section 2 comprises a tractor feeder having an endless tractor 21 and a motor 9. The tractor 21 is trained between and around a driving wheel 21a and a driven wheel 21b, and has one widthwise side portion having feed pins 12 for engagement with the

aforementioned perforations 11. The tractor 21 revolves with rotation of the driving wheel 21a (driven by the motor 9) with the feed pins 12 disengageably engaging the corresponding perforations 11 of the printing paper sheet 1 in sequence. This results in feeding the printing paper sheet 1 toward the downstream side by traction.

If a portion of the printing paper sheet 1 (which remains unprinted) is left in the feeding section 2 (at the time the printing with respect to the printing paper sheet 1 has been completed), the tractor 21 is revolved backwards by the motor 9 to return the unprinted portion of the printing paper sheet 1 to the paper supply section 20.

The braking device 19 functions to provide a variable braking force against the feeding force applied to the printing paper sheet 1 by the fusing section 4. The braking device 19, as shown in Figs. 3 and 4, includes a brake case 5 disposed to face the reverse side of the printing paper sheet 1, an evacuation fan 19a for producing a negative pressure in the brake case 5 by evacuating the brake case 5, and a fan motor 6 for driving the evacuation fan 6. The brake case 5 has an upper wall surface serving as a guide surface 14 for guiding the printing paper sheet 1. The guide surface 14 comprises a perforated plate

defining a multiplicity of air-suction perforations.

A guide roller 18 is disposed adjacent to the braking device 19, on the upstream side thereof. The guide roller 18 guides the printing paper sheet 1 so that the sheet 1 is brought into intimate sliding contact with the upper surface 14 of the brake case 5.

A negative pressure is produced in the brake case 5 by evacuation when the printing paper sheet 1 passes the guide surface 14 of the braking device 19. Hence, a suction force is exerted on the printing paper sheet 1 through the air-suction perforations 15. In this way, the printing paper sheet 1 is applied with a braking force produced by the sliding resistance between the printing paper sheet 1 and the guide surface 14.

As shown in Figs. 3 and 4, a partition plate 19b is provided within the brake case 5 to adjust the width of the internal space of the brake case 5, according to the width W of the printing paper sheet 1. Attached to the partition plate 19b is a thumbscrew 19d which protrudes upwardly outwardly from the brake case 5 through a guide slot 19c defined in the guide surface 14. The guide slot 19c extends widthwise of the printing paper sheet 1 (in the direction indicated by arrow b) to allow the thumbscrew to

shift along the guide slot 19c, thereby allowing the partition plate 19b to shift widthwise of the printing paper sheet 1. Specifically, the thumbscrew 19d is moved to position the partition plate 19b to a location depicted by the chain line in Fig. 4 when the width W of the printing paper sheet 1 is larger. Alternatively, the thumbscrew 19d is moved to position it to a location depicted by the solid line when the width W of the printing paper sheet 1 is smaller. This arrangement causes a suction force to effectively work on the printing paper sheet 1 within a space having a width adjusted to the width of the printing paper sheet 1.

The CPU 10 controls the operation of the motor 9 of the feeding section 2, sets a braking force according to a set brake value input from a setting panel 8, and controls the motor control circuit 7. The motor control circuit 7 controls revolutions of the evacuation fan 6 to provide a braking force according to the setting.

Fig. 5 is a front elevational view of the setting panel 8. The setting panel 8 is capable of displaying a "SUCTION BRAKE SETTING" picture 8a (as shown in the drawing) on an LCD panel that is operable by touch. For the user to become capable of inputting a desired set brake

value, the picture 8a has a set brake value display section 8b for displaying any one of integers from 1 to 8, an up key (▲ key) 8c for displaying a larger integer in the set brake value display section 8b, a down key (▼ key) 8d for displaying a smaller integer in the set brake value display section 8b, and a return key 8e for setting the integer displayed in the set brake value display section 8b as a set brake value.

In selecting a desired set brake value, the user causes the display panel to display the "SUCTION BRAKE SETTING" picture 8a, presses either the up key (▲ key) 8c to increase the set brake value or the down key (▼ key) 8d to decrease the set brake value, and presses the return key 8e when the desired set brake value is determined.

Fig. 6 shows the relationship between set brake value x and braking force y. The CPU 10 controls the motor control circuit 7, based on set brake value x input from the setting panel 8, so that braking force y plotted by the alternate long and short dash line in Fig. 6 is obtained. Braking force y plotted by the alternate long and short dash line is defined by the following formula:

$$y = 0.0994x - 0.0172$$

It should be noted that the solid line plots measured

braking forces actually obtained.

The principal operation of the continuous paper feeding device A shown in Fig. 1 is described below with reference to the flowchart shown in Fig. 7.

First, the printing paper sheet 1 delivered out of the paper supply section 20 is set on the feeding section 2, so that the perforations 11 of the paper sheet 1 engage the corresponding feed pins 12 of the tractor 21 (step 101). With the printing paper sheet 1 in this state, the fusing rollers 4a and 4b are actuated while, on the other hand, the motor 9 of the feeding section 2 is driven to cause the tractor 21 to revolve. As the tractor 21 revolves, the printing paper sheet 1 is fed toward the printing device 3 (102). Thereafter, the fan motor 6 is caused to rotate (201).

In the printing device, a toner image on the photosensitive drum 3 is transferred onto the printing paper sheet 1 by the transfer roller 13. Thereafter, the printing paper sheet 1 is fed toward the fusing section 4 (103) where the toner image is fused to the printing paper sheet 1.

Tension resulting from the feeding force of the fusing rollers 4a and 4b is not exerted on the printing

paper sheet 1 during the passage of the printing paper sheet 1 up to the fusing section 4 through the printing device 3. Hence, any stress is not imposed on the perforations 11 during this period because the paper sheet 1 is fed by the feeding section 2. Accordingly, there is no need to apply any braking force to the printing paper sheet 1 on the upstream side of the feeding section 2. However, taking into account that there is a time lag between the actuation of the fan motor 6 and the buildup of a negative pressure in the brake case 5, the fan motor 6 is preferably actuated before the printing paper sheet 1 reaches the fusing section 4.

As described above, the feeding speed of the pair of fusing rollers 4a and 4b is established so as to be slightly higher than that of the feeding section 2. Hence, a tensile force toward the downstream side is applied to the printing paper sheet 1 on the tractor 21 after the paper sheet 1 has reached the fusing section 4. This results in a tensile stress is imposed on the perforations 11 (103).

At this time, the brake case 5 of the braking device 19 is evacuated by the fan motor 6, a negative pressure is produced within the brake case 5 and applied to the

printing paper sheet 1 passing the guide surface 14 of the brake case 5 (202). Accordingly, a suction force is exerted on the reverse side of the printing paper sheet 1 through the air-suction perforations 15. At the same time, the atmospheric pressure is working on the obverse side of the paper sheet 1. Thus, the printing paper sheet 1 is fed as pressed against the guide surface 14 of the brake case 5.

When the printing on the printing paper sheet 1 has been completed (104), the rotation of the fusing rollers 4a and 4b and the feeding of the printing paper sheet 1 are stopped. The revolution of the fan motor 6 is also stopped (203). The user can then cut off the printing paper sheet 1 printed with an image fused thereto at a given perforation line P.

Thereafter, if an unprinted portion of the printing paper sheet 1 is left at the feeding section 2, the unprinted portion is returned to the paper supply section 20 by causing reverse rotation of the motor 9 of the feeding section 2 (105). At this time, a negative pressure is no longer produced within the brake case 5 due to stoppage of the fan motor 6. Hence, the braking force applied to the printing paper sheet 1 is released (204).

Accordingly, the printing paper sheet 1 is smoothly returned to the paper supply section 20 while sliding on the guide surface 14 without being pressed against the guide surface 14.

In the embodiment described above, the sliding resistance according to the coefficient of friction between the printing paper sheet 1 and the brake case 5 functions as a braking force. Accordingly, the feeding tension exerted on the printing paper sheet 1, on the downstream side of the feeding section 2 (on the paper ejecting side), and that exerted on the paper sheet 1 (on the upstream side of the feeding section) are balanced. As a result, the tensile stress imposed on the feed pins 12 of the feeding section 2, and on the perforations 11 of the printing paper sheet 1, is suppressed. The occurrence of hole breakage acting to enlarge the perforations 11 is prevented in this way.

Further, the motor control circuit 7 controls revolutions of the fan motor 6 according to the braking force set by the CPU 10. This causes the braking device 19 to apply an optimized braking force to the printing paper sheet 1. Accordingly, even when the paper feeding force is unstable, the braking force is adjusted to

accommodate the situation. Hence, the tension applied to the printing paper sheet 1 is made constant to ensure stabilized feeding. In this way, the positional precision of the printing paper sheet 1 relative to the printing device 3 can be maintained favorably.

Furthermore, since the braking device 19 is constructed of suction means, the printing paper sheet 1 is not damaged when applied with the braking force.

Although the foregoing embodiment is configured to have the user input a set brake value, the continuous paper feeding device may also be configured to have the user input the properties of a printing paper sheet 1, such as thickness t or width w, and the environmental conditions, such as the humidity of the atmosphere around the installation site. Fig. 8a is a table showing an example of a set brake value corresponding to a braking force for each paper sheet thickness t, Fig. 8b is a table showing an example of a set brake value corresponding to a braking force for each paper sheet width w, and Fig. 8c is a table showing an example of a set brake value corresponding to a braking force for each humidity degree of a printer-installed environment. These set brake values are previously stored in table form in a storage device

incorporated in the printer. Referring to Fig. 8a, when the user inputs, for example, 58 as the paper sheet thickness, the CPU references the table stored in the storage device and establishes a set brake value of 7. Once the set brake value of 7 has been established, the CPU sets braking force y calculated according to the aforementioned formula as in the foregoing embodiment.

By configuring the continuous paper feeding device, so as to have the user input the properties of a printing paper sheet or the environmental conditions as described above, feeding forces respectively working on the upstream and downstream sides of the feeding section 2 are balanced without being influenced by any change in the type of paper sheet or in the conditions of the installation environment. Thus, the continuous paper feeding device is capable of feeding printing paper sheet 1 in a constantly stabilized state, thereby assuredly preventing deviations of the printing position.

The continuous paper feeding device may be configured to have the user input a specific value as one of the properties of a printing paper sheet to be used or as one of the environmental conditions. Alternatively, it may be configured to have the user select one of predetermined

levels of a sheet property or an environmental condition, such as "HIGH", "MEDIUM" and "LOW".

Fig. 9 illustrates a continuous paper feeding device as a second embodiment of the present invention. Like or corresponding parts are designated by like reference numbers throughout Figs. 1 and 9 to avoid repetition of description thereof.

While the embodiment shown in Fig. 1 is configured to set a braking force to be applied by the braking device 19 according to data input from the setting panel by the user, the embodiment shown in Fig. 9 is configured to cause the CPU to set a braking force automatically.

Specifically, continuous paper feeding device A (shown in Fig. 9) is provided with a sensor 23 for judging whether a paper sheet is passing and detecting sheet width W, a sensor 24 for detecting the distance up to a paper sheet and determining sheet thickness t based on the distance thus detected, and a sensor 25 for detecting the humidity of the atmosphere around the printer-installed site. CPU 10 establishes a braking force by making synthetic judgment from all the results output from the sensors 23 to 25.

In this embodiment, an optimized braking force with

respect to printing paper sheet 1 is automatically established even when there is any change in the type of a paper sheet, such as sheet width W or sheet thickness t, or in the humidity of the printer-installed environment.

It should be noted that the locations of the sheet width detecting sensor 23, sheet thickness detecting sensor 24 and the humidity detecting sensor 25 are not limited to those shown in Fig. 9 and may be determined as desired. For example, it is possible that the sheet width detecting sensor 23 and sheet thickness detecting sensor 24 may be disposed adjacent to the paper supply section 20.

Fig. 10 illustrates a continuous paper feeding device incorporating a braking device 39 of a different type as a third embodiment of the present invention. Like or corresponding parts are designated by like reference numbers throughout Figs. 1 and 10 to avoid repetition of description thereof.

The braking device 39 shown in Fig. 10 comprises a pair of braking rollers 31 and 32 located upstream of the feeding section 2 and holding printing paper sheet 1 therebetween from its obverse and reverse sides. The braking roller 31 is freely rotatable as the printing paper sheet 1 moves. The braking roller 32 is connected to an

electromagnetic brake 33 for imposing a load on the braking roller 32 rotating. The electromagnetic brake 33 varies the load on the braking roller 32 according to its electromagnetic force varied by a current control circuit 43 controlling the amount of electric current.

With this arrangement, CPU 10 selects a braking force according to a set brake value established through the setting panel 8, and the current control circuit 34 controls the amount of current passing through the electromagnetic brake 33. In this way, the braking rollers 31 and 32 provide an optimized braking force. Accordingly, the printing paper sheet 1 can be applied with a braking force meeting the sheet properties or the environmental conditions. Hence, a stabilized feeding state is maintained thereby ensuring a print without any deviation of the printing position. Further, the continuous paper feeding device, according to this embodiment, has another advantage that the braking device 39 is of a simplified construction because a braking force applied to the printing paper sheet 1 is produced by the pressing force of the braking rollers 31 and 32.

Fig. 11 is a perspective view showing a continuous paper feeding device as a fourth embodiment of the present

invention. Like or corresponding parts are designated by like reference numbers throughout Figs. 1 and 11 to avoid repetition of description thereof.

Continuous paper feeding device A (shown in Fig. 11) is provided with hole breakage detection means 43 comprising a hole breakage detecting sensor 41 and a hole breakage detecting circuit 42.

The hole breakage detecting sensor 41 comprises a reflection type photosensor, the output of which becomes "ON" or "OFF" depending upon whether it receives reflected light of light directed at the perforated region of printing paper sheet 1.

As shown in Fig. 12, a cylindrical non-reflective member 12a is fitted over the peripheral portion of each feed pin 12 of the tractor 21. This prevents the peripheral surface of the feed pin 12 from reflecting light emitted from the hole breakage detecting sensor 41. On the other hand, a central portion of the top face of each feed pin 21 is provided with a white reflective surface 12b for reflecting light from the hole breakage detecting sensor 41.

When a perforation and a feed pin are engaged and do not face the hole breakage detecting sensor 41 (as shown in

Fig. 12a), light from the hole breakage detecting sensor 41 is reflected by a surface of the non-perforated region of the printing paper sheet 1. The output of the hole breakage detecting sensor 41 receiving the reflected light is in the "ON" state.

When the perforation and the feed pin engaged and are to face with the hole breakage detecting sensor 41, light from the hole breakage detecting sensor 41 is not reflected at the peripheral portion 12a of the feed pin 12. Hence, the output of the hole breakage detecting sensor 41 becomes "OFF". At the central portion of the top face of the feed pin 12, light from the hole breakage detecting sensor 41 is reflected by the white reflective surface 12b. Hence, the output of the hole breakage detecting sensor 41 receiving the reflected light becomes "ON".

In a normal state where the perforation 11 has no hole breakage (as shown in Fig. 12a), the feed pin 12 is fitted in the perforation 11 with substantially no clearance therebetween. Accordingly, the output of the hole breakage sensor 41 becomes "OFF" when the peripheral portion 12a of the feed pin 12 passes the sensor 41. Since the peripheral portion 12a has an equal width on diametrically opposite sides thereof, the respective

periods of two "OFF" outputs obtained when one feed pin 12 has passed the hole breakage detecting sensor 41 are equal to each other.

On the other hand, in a state where the perforation 11 has hole breakage at its peripheral edge on the upstream side thereof, and a clearance g is defined downstream of the perforation 11 (as shown in Fig. 12b), or where the perforation 11 has hole breakage at its peripheral edge on the downstream side thereof and a clearance g is defined upstream of the perforation 11 (as shown in Fig. 12c), light directed toward the clearance g from the hole breakage sensor 41 reaches a surface of the tractor 21 through the clearance g. Since the surface of the tractor 21 does not reflect light, the output of the hole breakage detecting sensor 41 becomes "OFF". Accordingly, the "OFF" period of the hole breakage detecting sensor 41 is prolonged by a time period corresponding to the clearance g. Thus, the amount of hole breakage is found from the length of an "OFF" period in an output waveform of the hole breakage detecting sensor 41, and the location of the hole breakage is determined from whether upstream or downstream of the perforation 11 a longer "OFF" period is located.

The hole breakage detecting circuit 42 forwards an

information signal indicative of the amount of hole breakage to the CPU 10 upon receipt of the output from the hole breakage detecting sensor 41.

The CPU 10 selects a braking force suited to the type of a paper sheet used or to the printer-installed environment from a prestored table of brake forces on the basis of the hole breakage information received from the hole breakage detecting circuit 42. The CPU 10 then forwards a PWM pulse signal corresponding to the braking force thus selected to the motor control circuit 7. According to the amount of hole breakage, the motor control circuit 7 controls revolutions of the fan motor 6 so that an appropriate braking force is applied to the printing paper sheet 1.

More specifically, when hole breakage such that clearance g is defined downstream of the perforation 11 is detected as shown in Fig. 12b, the CPU 10 judges that the braking force applied by the braking device 19 is smaller than the feeding force of the fusing section 4 and controls the braking device 19 so that a larger braking force is applied. Conversely, when hole breakage such that clearance g is defined upstream of the perforation 11 is detected as shown in Fig. 12c, the CPU 10 judges that the

braking force applied by the braking device 19 is larger than the feeding force of the fusing section 4 and controls the braking device 19 so that a smaller braking force is applied. By so doing, the feeding force of the fusing section 4 and the braking force of the braking device 19 become well-balanced thereby preventing the hole breakage from becoming larger, ensuring a satisfactory printing precision.

Fig. 13 illustrates hole breakage detection means of another type. In Fig. 13, the hole breakage detecting sensor 41 is disposed facing the underside of the tractor 21. At the root of each feed pin 12, the tractor 21 defines upstream through-hole 51 and downstream through-hole 52 of the same size.

In a normal state where each perforation 11 of the printing paper sheet 1 has no hole breakage (as shown in Fig. 12a), light from the hole breakage detecting sensor 41 is not reflected during a period for which a through-hole free region on the underside of the tractor 21 faces the hole breakage detecting sensor 41. Accordingly, the output of the hole breakage detecting sensor 41 is in the "OFF" state. On the other hand, during a period for which the through-hole 51 or 52 faces the hole breakage detecting

sensor 41, light from the hole breakage detecting sensor 41 passes through the through-hole 51 or 52 and is reflected by the reverse side of the printing paper sheet 1. Accordingly, the output of the hole breakage detecting sensor 41 assumes "ON" for a time period for which the sensor receives the reflected light.

In the case where there is no hole breakage, the output of the hole breakage detecting sensor 41 becomes "ON" when the upstream through-hole 51 or the downstream through-hole 52 passes the sensor 41. Since the two through-holes are of the same size, respective periods of the two "ON" outputs obtained when one feed pin 12 has passed the hole breakage detecting sensor 41 are equal to each other.

On the other hand, in the case where the perforation 11 has hole breakage at its peripheral edge on the upstream side thereof and a clearance g is defined downstream of the perforation 11 (as shown in Fig. 13b), the output of the hole breakage detecting sensor 41 assumes "ON" during a time period for which light penetrating through the upstream though-hole 51 from the hole breakage detecting sensor 41 is being reflected by the reverse side of the printing paper sheet 1. However, this "ON" period is

shortened because light from the hole breakage detecting sensor 41 is not reflected during a time period for which the light is passing through the clearance g. Likewise, in the case where the perforation 11 has hole breakage at its peripheral edge on the downstream side thereof and a clearance g is defined upstream of the perforation 11 (as shown in Fig. 13c), the "ON" period of the hole breakage detecting sensor 41 is shortened because light penetrating through the through-hole 52 from the hole breakage detecting sensor 41 is not reflected during a time period for which the light is passing through the clearance g. Accordingly, the "ON" period of the hole breakage detecting sensor 41 is shortened by a time period corresponding to the clearance g. Thus, the amount of hole breakage is found from the length of an "ON" period in an output waveform of the hole breakage detecting sensor 41, and the location of the hole breakage is determined from whether upstream or downstream of the perforation 11 a shorter "ON" period is located.

The hole breakage detection means may comprise any other type of sensor than the optical sensor 41 described above, image pick-up means or like means.

While the feeding section 2 is constructed of a

tractor feeder in each of the foregoing embodiments, the construction of the feeding section 2 is not limited thereto.

It should be further noted that the braking device 19 or 39 may be of any construction other than described above.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to noted that various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modification depart from the scope of the present invention, they should be construed as being included there in.